THE NEWS LETTER
OF THE
BUREAU OF PUBLIC ROADS

VOL. 3, NO. 5 MARCH, 1928 A. C. ROSE, EDITOR

CONTENTS

BUREAU RUSHES CONSTRUCTION OF TEMPORARY BRIDGE TO RELIEVE VERMONT FLOOD SITUATION

Compiled from report made by W. J. Anderson of District 3.

To repair the disrupted transportation system of the Winooski River Valley in Vermont, following the recent New England flood, the Bureau rushed to completion an ingenious temporary wooden bridge.

The railroad through the valley was damaged beyond hope of immediate repair, and the entire burden of transportation was thrown upon the highway on which, between Burlington and Montpelier, there were two crossings of the Winooski River at which the bridges had been washed away. It was, therefore, imperative that these structures be replaced as quickly as possible so that the work of rehabilitating the devastated area could be expedited in anticipation of the coming winter.

The responsibility for the construction of one of the two bridges - that at Middlesex, Vt. - was delegated to the Bureau. The river at this point is 225 feet wide; and all that was left of the former bridge were two dry-rubble abutments and a rubble river pier, the latter so located as to divide the stream into two channels of which one was 97 feet wide in the clear with a low-water depth of 6 feet, and the other 116 feet wide with a depth of 8 feet at low water. The velocity of the stream at times approached 15 miles an hour.

In 12 days after the arrival of the materials, and at a cost of about $9,000, much of which is salvable, the Bureau completed on this location a bridge which has a carrying capacity of 8 tons (fig. 1) and which is of more than usual interest because of the manner in which difficulties arising from the scarcity of material and labor were overcome in the design (fig. 4) and construction.

Since the reconstruction work was governed largely by local conditions, three methods of bridging the openings were suggested:

1.- A plank floor laid on stringers supported by pile bents.

2.- A plank floor laid on stringers resting on timber cribs.

3.- A truss constructed either of timber or a combination of timber and wire cable.

Figure 1. - The completed temporary combination timber and cable-truss bridge across the Winooski River near Middlesex, Vt.

Figure 2. - The temporary foot-bridge and a close-up view of the main timbers and the strut bents.

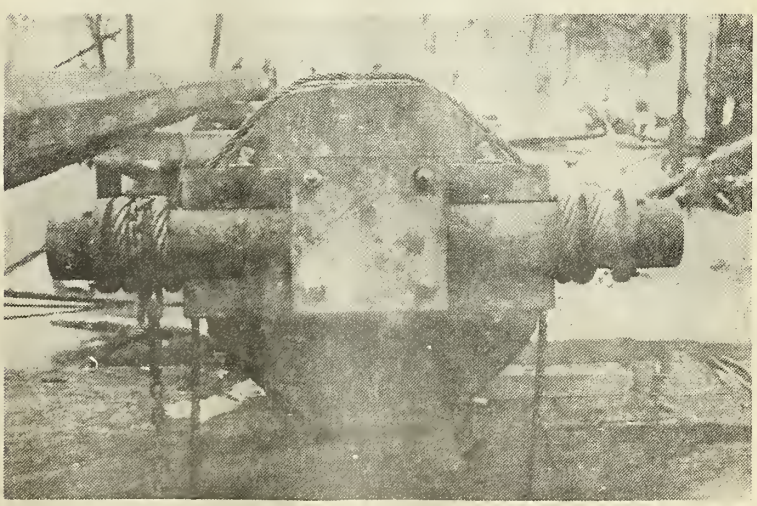


Figure 3. - The cables were fastened to the ends of the timbers with 5⅛-inch-diameter steel shafting resting in a cast-iron pillow block.

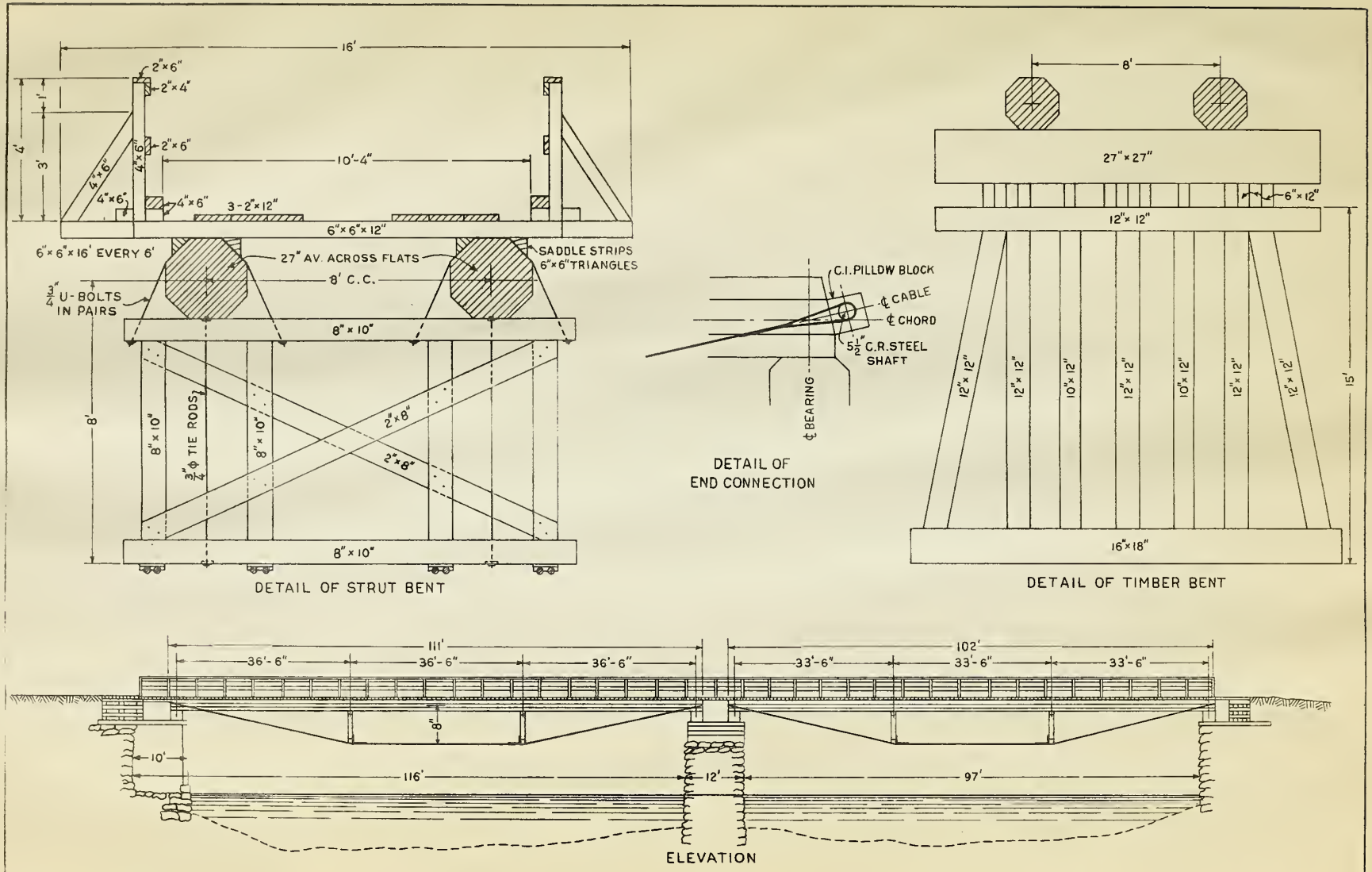


FIGURE 4-TEMPORARY BRIDGE BUILT BY THE BUREAU OVER THE WINOOSKI RIVER IN THE TOWN OF MIDDLESEX, VERMONT

Because of the heavy flow of ice and drift in the river and the possibility of another flood, it was decided that any design which would keep the river free of obstruction would be far superior to either of the first two methods. Therefore, a survey of the surrounding region was made to determine whether there was material available to construct a truss bridge.

It was found that the flood had carried away practically all of the dimension lumber and cement in the vicinity, that there were no steel beams available, and that labor was scarce. A further investigation, however, indicated that, in the Barre granite quarries, there were a number of octagonal Douglas-fir derrick masts varying in length from 70 to 112 feet, and, in cross section, from 24 to 30 inches across the flats. In each quarry, also, there was a crew of experienced riggers. It was decided, therefore, to construct, from these derrick masts, two long queen-post trusses with the tensile stresses carried by steel cables.

Method of Transporting Materials to the Bridge Site

Four of the Douglas-fir timbers were selected. Two were 102 feet long, and the others were 111 and 112 feet in length, respectively. These were loaded on flat cars, at the quarries, and hauled over the only remaining railroad to Montpelier, where they were unloaded and transported by highway to the bridge site - 6 miles distant.

One end of each of the timbers was rolled from the railroad flat cars onto a motor truck and the other end was placed upon the bolster of a heavy two-wheel trailer, an arrangement suggested by the necessity of making right-angle turns in the city of Montpelier as well as at two highway underpasses and one overpass. About 10 hours were required to transport the timbers from the railroad yard to the bridge site.

Method of Construction

While the wooden masts were being moved by one crew, another group of riggers built a foot bridge (Fig. 2) across the river, adjacent to the proposed bridge. This crossing consisted of two 3/4-inch steel cables, spaced 5 feet apart, and cross-planked with 2-inch boards. Then 40-foot gin poles were erected on the downstream end of each abutment and pier so as not to interfere with the construction of the main bridge.

The abutments and piers, which had been partially destroyed by the flood, were brought to grade with timber cribs upon which were placed 27-inch square caps of Douglas-fir timber cut from broken masts found in the quarries. All the cribbing was drift-spiked to prevent movement and the center crib was constructed entirely across the pier which was 12 feet wide.

The available timbers were then selected to fit the proper openings. For the 97-foot span the two 102-foot timbers were used without cutting, and for the 116-foot span the other two timbers were used - one foot being cut off the longer one to make them both 111 feet in length. Because the two longest timbers fell short of the required length, it was necessary to erect a timber bent at a distance of 10 feet from one abutment. Fortunately an outcropping rock was so situated that the bent could be anchored to it by means of steel cables.

All the timbers in the cribs and bent were of seasoned, hard pine salvaged from far and near. Some were from old barn frames and others from the remains of old bridges. They varied from 8 by 10 to 10 by 10 inches in cross section. The strut bents, made of 8 by 10-inch timbers, were constructed on the river bank and swung into position with blocks and tackle. The panel lengths were 33 feet 6 inches in the shorter span and 36 feet 6 inches in the longer one. In each span the depth of the truss from the center of the compression timbers to the tension cables was 8 feet.

Because of the long spans and the limited height of the strut posts, it was computed that four $1\frac{1}{4}$-inch yellow-strand plow-steel cables would be necessary, under each timber, in order to provide sufficient tensile strength. These were placed in pairs under each side of the member which they were supporting. The cables were fixed to the ends of the timber (fig. 3) by means of a $5\frac{1}{2}$-inch steel shaft resting in a cast-iron pillow-block. The shafts and castings were fitted to the timbers in the river bank after the ends had been cut to the proper angle.

It was a simple matter to place the large timbers in position by using the gin poles in pairs. Blocks and tackle were attached to the top of each gin pole. A 5-ton tractor furnished the power for one gin pole and a $3\frac{1}{2}$-ton truck for the other. In order to move a timber, tackles were fastened to one end and the center of its length.

Both tackles were then hoisted and by pulling alternately on the end, and slacking off on the other tackle, the timber was gradually pulled across the channel. The grip around the midpoint of the timber was moved back several times until at the final pull it was attached to the end opposite the hauling tackle. After the first-span timbers were in place and trussed, the longer masts were moved across the timbers already in place, and the gin poles on the pier and further abutment were used to move them over into the second span.

As no turnbuckles were available, it was necessary to use the tackle for tightening the cables. A grip was taken in the center of each timber and a strain applied to it so as to produce a 10-inch camber. The cables were then pulled taut with chain hoists and the clips attached. When the tackles were slacked off, as may be seen from Figure 1, the bridge floor became practically level.

In order to overcome the tendency of the strut bents to collapse inwards, right-angle bar braces were clamped to the cable behind the bents. The bars were made of $1\frac{1}{4}$-inch round steel in pieces 26 inches long, bent into the shape of a right angle, with the legs 18 and 8 inches long, respectively. The 8-inch leg was placed against the side of the bent and stapled into place so as to prevent the rod from turning sidewise.

For the construction of the floor it was found that 12-foot spruce logs were the only material which could be obtained quickly. Accordingly these logs were sawed into 12-foot planks 6 inches thick. This provided a roadway width of 10 feet inside the curbs. The trusses, accordingly, were spaced 8 feet apart from center to center.

Extreme care was used to preserve the large timbers from spike holes and other damage because the State Highway Board believed they had a considerable salvage value. To reduce the damage to the minimum, triangular strips were tacked lightly on each of the top slopes of the octagon so as to provide a suitable spiking surface. These strips were made of 6-inch by 6-inch spruce sawed on the diagonal.

The railing was constructed of 4-inch by 6-inch spruce posts, 4 feet long, spaced 6 feet apart, since the rails could only be obtained in 12-foot lengths. At every other post on each side, a 16-foot plank was placed in the floor so that its 4-foot extension

PROVIDED ROOM FOR BRACING THE RAIL. IN FRONT OF EACH POST, 4-INCH BY 6-INCH BLOCKS, 1 FOOT LONG, WERE SPIKED TO THE FLOOR. UPON THESE BLOCKS 4-INCH BY 6-INCH CURBS WERE FIXED IN POSITION WITH DRIFT BOLTS. THE RAILS WERE MADE OF 2-INCH BY 6-INCH PLANKS. ONE RAIL WAS PLACED AT HUB HEIGHT ABOVE THE FLOOR AND THE OTHER TWO WERE FRAMED AT THE TOP OF THE POSTS TO STIFFEN THE RAILING. IN ORDER TO REDUCE THE VIBRATION, PLANK SOLES 36 INCHES WIDE BY 2 INCHES THICK WERE SPIKED LONGITUDINALLY IN THE WHEEL TRACKS.

AFTER THE BRIDGE PROPER HAD BEEN COMPLETED, THE TIMBER BENT, FORMING THE NEW ABUTMENT, WAS PLANKED DIAGONALLY ON BOTH SIDES FOR PROTECTION AGAINST THE DESTRUCTIVE ACTION OF DRIFTING ICE AND DEBRIS. IN ADDITION A "GUARD CRIB" WAS BUILT, A SHORT DISTANCE UPSTREAM, THAT PROJECTED FAR ENOUGH OUT INTO THE WATER TO SHIELD THE BENT FROM FLOATING OBJECTS. THIS CRIB HAD A PLANK BOTTOM AND LINING SO THAT IT COULD BE FILLED WITH GRAVEL. AS AN ADDITIONAL PRECAUTION, THE CRIB, TRUSSES, AND TIMBER BENT WERE SECURELY ANCHORED TO TREES UPSTREAM ON EITHER SIDE.

--- ---

CLIFFORD SHOEMAKER GOES TO DISTRICT 5

EFFECTIVE APRIL 1, CLIFFORD SHOEMAKER, FORMERLY PRINCIPAL ASSISTANT TO MR. BISHOP, CHIEF OF THE DIVISION OF CONSTRUCTION, BECOMES DISTRICT ENGINEER OF DISTRICT 5, WITH HEADQUARTERS AT OMAHA, NEBR. MR. SHOEMAKER TAKES OVER THE DUTIES FORMERLY IN CHARGE OF MR. LYNCH WHO HAS BEEN TRANSFERRED TO DISTRICT 1 TO FILL THE VACANCY CAUSED BY MR. PURCELL'S RESIGNATION.

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

STATUS OF CURRENT FEDERAL-AID ROAD WORK

FOR THE FISCAL YEAR ENDING JUNE 30, 1928

AS OF FEBRUARY 29, 1928

STATES	BALANCE OF FEDERAL-AID FUND AVAILABLE FOR NEW PROJECTS	*UNDER CONSTRUCTION			APPROVED FOR CONSTRUCTION			AMOUNT PAID STATES DURING FISCAL YEAR	COMPLETED AND PAID DURING FISCAL YEAR			AGREEMENTS NOW IN FORCE			P. S. & E. RECOMMENDED FOR APPROVAL BY DISTRICT ENGINEER			STATES
		FEDERAL AID	MILEAGE		FEDERAL AID	MILEAGE			FEDERAL AID	MILEAGE		FEDERAL AID	MILEAGE		FEDERAL AID	MILEAGE		
			ORIGINAL	STAGE		ORIGINAL	STAGE			ORIGINAL	STAGE		ORIGINAL	STAGE		ORIGINAL	STAGE	
Alabama	$ 2,624,071.23	$ 4,426,605.45	498.8	26.6	$ 182,411.03	36.3		$ 1,587,914.34	595,070.35	79.1		$ 3,459,795.74	402.1	1.9	$ 1,149,220.74	133.0	24.7	Alabama
Arizona	3,949,271.70	827,674.26	66.1	4.4	58,152.85	0.5	0.6	288,199.84	461,055.92	15.7		844,938.70	66.3	4.9	40,888.41	0.3		Arizona
Arkansas	2,167,002.23	2,060,264.76	227.7		340,850.92	14.2		256,371.98	72,184.34	13.4		1,939,986.90	217.7		461,118.78	24.2		Arkansas
California	4,715,188.61	3,227,432.68	142.8	5.7	168,949.52	9.5	0.6	1,713,021.71	1,974,069.47	101.1	0.3	3,182,252.21	141.6	5.7	204,129.99	10.8	0.6	California
Colorado	3,568,753.91	3,446,538.91	264.3	12.4	74,993.56	7.0		690,796.09	62,147.72	1.7		3,401,275.77	272.0	12.4	119,256.69	19.3		Colorado
Connecticut	680,332.03	1,597,373.38	69.6		191,246.72	12.0		162,520.95	367,826.33	17.7		1,679,085.08	76.1		109,536.02	6.4		Connecticut
Delaware	365,625.26	262,068.47	15.3	2.1				232,041.85	232,041.85	29.4		244,686.47	16.3	2.1	17,382.00			Delaware
Florida	1,361,791.88	2,455,558.94	136.3	5.4	413,332.53	27.8		1,033,616.41	2,026,119.96	83.1	24.7	2,208,177.02	126.3		661,714.55	37.8	5.4	Florida
Georgia	1,701,917.40	2,125,292.33	187.9	28.5	285,372.71	34.8	4.0	1,692,732.94	3,177,362.16	227.2	121.0	1,999,800.96	164.3	25.9	410,864.08	58.4	6.5	Georgia
Idaho	867,661.00	1,316,509.65	142.3	59.0	218,500.00	21.8	4.8	763,551.64	949,584.29	111.0	14.8	999,804.16	113.6	28.1	535,205.39	50.6	35.7	Idaho
Illinois	3,593,397.02	7,196,617.81	500.2	2.2	1,800,102.31	124.4		1,983,250.35	750,218.26	65.5		6,805,891.14	486.9		2,190,828.98	138.7	2.2	Illinois
Indiana	1,037,937.71	7,875,318.94	497.2		1,244,594.77	92.3	3.5	1,603,739.38	656,170.38	48.5		7,659,156.73	487.5		1,460,756.98	102.0	3.5	Indiana
Iowa	624,843.01	4,643,249.80	283.1	167.3	1,344,064.66	17.2	97.7	2,472,146.99	2,558,101.78	334.0	66.5	4,268,898.46	287.8	143.3	1,720,406.00	12.6	121.7	Iowa
Kansas	2,192,817.08	4,434,160.43	594.7	7.3	82,000.00	6.6		2,563,910.40	2,175,332.01	297.0	10.2	4,327,636.51	579.2	3.5	168,523.92	22.0	3.9	Kansas
Kentucky	1,406,474.84	4,298,703.56	394.5	62.3	26,000.00	5.4		1,845,166.00	810,911.86	78.0	17.1	4,248,745.22	391.1	62.3	74,958.33	8.8		Kentucky
Louisiana	352,353.61	2,415,139.55	143.0	7.6	845,811.26	103.9		527,696.81	597,801.48	48.7		2,205,861.83	151.8	7.5	1,055,088.97	95.1		Louisiana
Maine	1,737,903.13	536,989.44	39.4		43,966.00	5.6		430,001.05	649,761.76	56.4		580,945.44	45.0					Maine
Maryland	620,161.03	532,862.17	49.6					391,014.57	517,120.53	54.9		485,662.17	49.6		47,200.00			Maryland
Massachusetts	2,583,239.41	1,865,290.01	115.4		253,911.69	17.1		158,264.74	158,264.74	9.6		1,898,790.01	117.5		222,411.69	15.0		Massachusetts
Michigan	1,790,210.56	6,115,105.81	302.1	3.4	1,296,587.00	79.1	6.5	1,945,224.57	2,236,263.64	163.8	9.2	4,100,180.81	256.8	3.4	2,311,512.00	124.4	6.5	Michigan
Minnesota	752,471.43	1,203,100.00	216.7	3.8	822,000.00	117.1	58.2	1,964,943.69	2,001,398.90	248.7	110.3	575,100.00	180.8	3.8	1,450,000.00	153.0	58.2	Minnesota
Mississippi	1,607,730.66	2,704,661.12	292.2	26.9	267,296.68	30.9		1,415,546.66	1,161,642.92	127.4	4.9	2,600,364.46	284.5	26.9	371,593.34	38.5		Mississippi
Missouri	2,781,203.20	2,733,535.37	210.0	22.7	382,344.58	45.5		2,201,601.20	2,017,748.37	150.1	25.4	2,708,598.61	210.0	18.9	407,381.34	46.6	3.9	Missouri
Montana	5,424,367.87	2,872,304.60	328.7	8.4	595,984.70	122.6		1,300,949.14	349,014.14	57.8	4.9	3,283,772.10	437.1	8.4	184,517.20	14.2		Montana
Nebraska	1,902,899.01	6,488,936.73	1,088.0	397.7	323,638.77	63.3	47.1	2,074,538.30	2,350,493.10	491.3	462.7	5,535,870.15	1,120.3	423.6	276,705.35	31.0	21.2	Nebraska
Nevada	977,388.68	1,519,620.31	195.7	26.0	62,063.22	8.7	6.4	608,017.46	653,479.11	78.2	10.7	1,396,036.96	169.4	29.0	185,646.57	35.0	2.4	Nevada
New Hampshire	373,607.84	381,165.64	23.8		23,296.00	1.5		287,579.96	343,846.47	26.0		404,460.64	26.3					New Hampshire
New Jersey	895,357.00	736,624.17	47.9		117,102.35	8.2		1,092,706.00	1,092,706.00	72.8		813,961.62	53.4		39,765.00	2.7		New Jersey
New Mexico	2,437,347.38	2,193,026.93	182.8					1,103,493.15	780,538.63	92.4		2,193,025.93	182.8					New Mexico
New York	9,613,235.78	10,382,746.45	648.2		1,111,402.50	71.7	8.6	3,651,709.29	1,608,949.62	106.6		11,229,248.95	700.2	8.6	264,900.00	17.7		New York
North Carolina	2,119,866.20	910,448.18	46.8	24.9	202,269.87	6.7		1,106,025.41	1,394,904.59	109.2	9.7	895,948.18	45.9	24.9	216,759.87	7.5		North Carolina
North Dakota	1,237,683.96	1,810,554.43	581.1	187.2	363,698.86	156.9	79.8	1,221,730.63	1,978,919.27	459.4	306.0	1,764,661.38	666.7	173.2	409,491.71	71.3	93.8	North Dakota
Ohio	4,545,757.50	3,495,477.63	224.9	4.2	1,518,761.26	91.8	8.8	1,632,599.98	2,360,605.95	189.3		3,034,049.53	201.5	4.2	1,980,179.26	115.2	8.8	Ohio
Oklahoma	1,688,586.01	2,875,610.49	396.6	21.4	499,203.30	67.3	3.8	978,284.20	379,754.99	9.6	17.9	2,800,880.96	394.8	25.2	573,932.83	59.1		Oklahoma
Oregon	1,586,711.23	1,426,367.68	76.6	41.9	68,963.27	0.9		424,908.68	137,760.88	11.2		1,462,966.86	76.6	35.8	22,364.10		6.1	Oregon
Pennsylvania	3,991,148.21	6,136,174.68	316.3		914,454.30	67.4		2,390,421.48	1,648,904.59	114.3	3.0	6,619,646.70	347.4		431,982.18	25.3		Pennsylvania
Rhode Island	683,722.53	389,422.41	24.2		99,990.00	5.5		296,987.48	227,205.00	16.1		469,412.41	30.8					Rhode Island
South Carolina	460,227.26	2,526,684.55	230.7	126.9	390,000.00	44.7	33.6	772,360.88	1,013,264.39	69.0	7.7	2,101,476.41	199.4	94.8	814,089.14	76.0	66.7	South Carolina
South Dakota	976,988.63	2,424,376.33	672.9	122.6	252,061.18	96.6	47.6	827,672.02	440,893.32	156.0	65.6	2,434,770.35	728.0	141.6	251,667.16	40.6	28.6	South Dakota
Tennessee	1,637,446.22	3,249,298.69	209.8	23.8	788,610.33	82.2	9.4	651,141.14	1,280,556.31	71.2	38.4	2,660,588.66	186.8	23.8	1,377,340.27	85.2	9.4	Tennessee
Texas	6,367,487.60	6,699,069.38	494.3	220.9	1,392,610.84	100.3	89.6	3,082,086.80	3,680,171.03	282.4	143.8	5,664,249.86	473.5	271.4	1,427,430.16	121.1	39.1	Texas
Utah	917,030.30	1,900,190.38	156.0	14.5	162,890.09	21.6		671,621.70	766,687.30	94.6		1,797,601.53	152.3	14.6	265,478.92	25.3		Utah
Vermont	394,748.54	683,331.78	43.6		1,000.00	0.8		620,623.08	571,622.87	27.9		583,331.78	43.6		1,000.00	0.6		Vermont
Virginia	1,025,898.06	1,779,122.88	92.9	4.0	482,391.37	27.5	6.4	1,109,368.70	577,220.45	36.5		1,777,464.39	93.1	4.0	464,049.88	27.3	6.4	Virginia
Washington	1,377,645.73	1,884,500.00	113.6		326,000.00	13.9	16.1	266,539.83	586,736.32	32.3		1,772,600.00	111.6		437,000.00	15.9	18.1	Washington
West Virginia	847,643.36	2,251,111.80	194.9	4.0	64,721.66	6.7		828,726.83	1,202,718.18	85.3	8.0	2,316,833.46	201.8	4.0				West Virginia
Wisconsin	3,689,877.54	2,768,278.69	221.6	26.7				2,746,341.45	2,887,668.97	246.0	17.3	2,682,824.69	208.6	26.7	185,464.00	13.1		Wisconsin
Wyoming	956,390.25	1,382,696.58	224.1	64.1				819,960.11	962,836.11	83.6	54.9	1,382,696.58	224.1	64.1				Wyoming
Hawaii	1,121,742.78	278,727.48	16.6		60,383.43	3.2		286,966.86	275,109.33	14.1		278,727.46	15.6		60,383.43	3.2		Hawaii
TOTALS	97,230,932.20	134,642,990.16	12,267.7	1,756.7	20,111,834.77	1,649.9	534.1	68,860,617.41	56,631,551.83	5,385.8	1,641.9	129,594,720.72	12,212.8	1,728.3	25,060,104.21	1,894.8	672.3	TOTALS

* Includes projects reported completed (final vouchers not yet paid) totaling: Federal aid, $ 44,394,532.63 Mileage: Original 3.990.7 Stage 693.4

ANSWERS TO MATERIALS ENGINEERS EXAMINATION

CONTRIBUTED BY F. H. JACKSON, H. M. MILBURN, AND L. G. CARMICK
OF THE DIVISION OF TESTS

(NOT FOR RELEASE)

THE CORRECT ANSWERS TO THE EXAMINATION GIVEN TO THE DISTRICT MATERIALS ENGINEERS AT THE HEADQUARTERS OFFICE, ON JANUARY 27, ARE GIVEN BELOW. THE 32 QUESTIONS TO WHICH THE ANSWERS ARE MADE, AND WHICH COVER PHASES OF THE WORK WITH WHICH EVERY MATERIALS ENGINEER SHOULD BE FAMILIAR WERE GIVEN IN THE FEBRUARY NEWS LETTER. AFTER EACH OF THE ANSWERS ARE GIVEN THE NAME AND DISTRICT NUMBER OF THE MATERIALS ENGINEER GIVING THE BEST ANSWER TO THE QUESTION. IN CASES WHERE NO ONE MADE A CORRECT STATEMENT, THE ANSWER IS GIVEN WITHOUT THE MENTION OF ANY NAMES. IN THE PROBLEMS WHERE A NUMERICAL RESULT REPRESENTED THE CORRECT SOLUTION, THE NUMBER OF THE EXAMINEES GIVING THE CORRECT ANSWER ARE STATED IN EACH CASE, AND IN ADDITION A CORRECT SOLUTION IS SHOWN.

1. - UNSOUNDNESS IN PORTLAND CEMENT IS CAUSED, ORDINARILY, BY THE PRESENCE OF AN EXCESS OF FREE OR UNCOMBINED LIME. IT IS DETECTED IN THE LABORATORY BY MEANS OF THE SO-CALLED "SOUNDNESS" TEST. IN THIS TEST, A PAT OF NEAT CEMENT IS PLACED IN AN ATMOSPHERE OF STEAM, ABOVE BOILING WATER, FOR FIVE HOURS, AND ITS CONDITION AS REGARDS CHECKING, WARPING, OR DISINTEGRATION IS NOTED. A SOUND PAT WILL REMAIN FIRM AND HARD, AND SHOW NO EVIDENCE OF CHECKING. UNSOUNDNESS IN THE FINISHED PRODUCT MAY FREQUENTLY BE CORRECTED BY ALLOWING THE CEMENT TO AGE BEFORE USING - IN THIS WAY, THE UNCOMBINED LIME IS AIR-SLAKED AND THUS RENDERED INERT. (C. ANDERSON OF DISTRICT 1)

2. - THE STRENGTH OF PORTLAND CEMENT IS LARGELY CONTROLLED BY THE AMOUNT OF LIME PRESENT - THE HIGHER THE PERCENTAGE OF LIME, THE GREATER THE STRENGTH. HIGH-LIMED CEMENTS, HOWEVER, WILL HAVE A TENDENCY TO RUN UNSOUND UNLESS GREAT CARE IS TAKEN IN THE MANUFACTURING PROCESS. THE TWO DETAILS WHICH ARE GENERALLY RESPONSIBLE FOR SECURING SOUNDNESS, WITHOUT SACRIFICING STRENGTH, ARE HARD BURNING AND THOROUGH GRINDING. THE FIRST OPERATION CONTROLS THE PROPORTION OF COMBINED LIME WHICH WILL BE OBTAINED, AND THE SECOND OPERATION INSURES A PRODUCT SUFFICIENTLY FINE SO THAT ANY UNCOMBINED LIME REMAINING WILL BE READILY AIR-SLAKED UPON EXPOSURE TO AIR. (A. F. HAELIG OF DISTRICT 7)

3. - THE PRESENT SPECIFICATION REQUIREMENTS FOR PORTLAND CEMENT ARE 225 POUNDS AT SEVEN DAYS AND 325 POUNDS AT 28 DAYS. (9 CORRECT ANSWERS)

4. - Sand-A. - This sand is well graded, carries a reasonable amount of silt and has a strength ratio comparable with the grading. For this reason an unfavorable color test is not considered significant. Nor is it particularly significant if the tensile-strength ratio at seven days is 2 per cent below the usual specification requirements. This variation is well within the limits of accuracy of the test and the sand would, therefore, be acceptable for use in concrete pavements.

Sand-B. - This sand is satisfactory in every respect except grading. Concrete in which it is used will be harsh and difficult to finish, although probably of high strength if rigid control is exercised over the water content. This sand would be considerably improved by mixing with a somewhat finer sand, such as Sand-D, so as to bring the per cent of material retained on the No. 10 sieve down to about 15, and raise the percentage passing the No. 50 to about 20. Freedom from silt is a very desirable quality.

Sand-C. - This sand is graded exactly like Sand-A except for silt content. The low strength-ratio, however, coupled with the fact that the color test is O.K. would indicate that the grains are structurally weak. This sand should be rejected.

Sand-D. - This sand is fine and has the maximum permissible percentage of silt. The strength ratio is comparable with the grading, indicating that the sand grains are structurally sound, even though the strength ratio is considerably below the conventional 100 per cent. Sand-D could be used satisfactorily if mixed in the proper proportions with a sand similar to B, or if used in a specially designed concrete mix.

Sand-E. - This sand is normally graded. The strength ratio, however, is low and the color test is questionable. The low strength-ratio in this case may be due either to the presence of organic matter or structurally unsound grains, or a combination of both. Therefore, this sand should not be used for concrete pavements. (H. C. Headley of District 8)

5. - The four distinct characteristics of concrete sand which affect the strength-ratio test are: (a) grading; (b) organic impurities; (c) amount of silt; (d) character of the grains, including shape, structure, mineral composition, etc. (H. J. Hemstreet of District 9)

6. - The color test for organic impurities is made by filling a 12-ounce clear-glass bottle up to the 4-1/2-ounce mark with the sand to be tested, adding a 3- per-cent solution of sodium hydroxide in water until the combined volume of the sand and liquid is 7 liquid ounces, shaking vigorously, and then allowing it to stand for 24 hours. The color of the clear liquid above the sand, at the expiration of 24 hours, compared with the color of a standard 2-per-cent tannic-acid solution, in a 3-per-cent sodium-hydroxide solution, is an indication of the amount of organic matter present. (H. C. Headley of District 8)

7. - The predominating physical characteristics of the so-called "trap" rocks are: Hardness, toughness, high specific gravity, and compactness of grain. Toughness or resistance to impact, may be considered their outstanding characteristic. They are particularly well adapted for use in the various types of macadam roads, particularly bituminous macadam and also various types of mixed bituminous concretes, and as binder stone for sheet asphalt, etc. The "traps" are as a class also extremely durable and are, therefore, well adapted for use as concrete aggregates. (W. D. Ross of District 3)

8. - The three principal groups into which road-building rocks are divided are: (a) Igneous; (b) sedimentary; and (c) metamorphic. Basalt belongs to the igneous group, sandstone to the sedimentary group, and schist, marble, and gneiss to the metamorphic. The foliated or laminated structure of the gneisses makes them frequently undesirable for use as concrete aggregates, due to the fact that they crush into flat, elongated pieces. (R. L. Devereaux of District 10)

9. - Limestones containing clay, usually termed "argillaceous" limestones, should be viewed with suspicion when intended for use as a concrete aggregate. Such material should only be used where previous experience has demonstrated beyond question that the rock is durable. Valuable information along this line may be obtained either by studying existing structures or by carefully examining exposed ledges of the stone for evidences of weathering. (H. S. Gillette of District 6)

10. - (a) The abrasion test on a limestone, intended for use as an aggregate in concrete pavements, might be waived in cases where it was possible to obtain concrete of satisfactory flexural strength with the aggregate involved, and in those locations where a negligible amount of surface wear would be expected.

(B) THE SODIUM SULPHATE SOUNDNESS TEST SHOULD BE WAIVED ONLY WHEN EITHER THE SERVICE BEHAVIOR OF THE STONE IN CONCRETE OR THE APPEARANCE OF EXPOSED LEDGES OR FACES INDICATE THAT IT IS DURABLE.

11. - THE THREE GENERAL PRINCIPLES, AS REGARDS SIZE AND GRADATION OF AGGREGATES, WHICH GOVERN THE PROPER RATIO IN WHICH THE FINE AND COARSE AGGREGATES SHOULD BE COMBINED ARE:

1. - THE FINER THE SAND, THE SMALLER THE AMOUNT OF SAND.
2. - THE FINER THE GRADING OF THE COARSE AGGREGATE FOR A GIVEN MAXIMUM SIZE, THE SMALLER THE AMOUNT OF SAND.
3. - THE SMALLER THE MAXIMUM SIZE OF COARSE AGGREGATE, THE LARGER THE AMOUNT OF SAND.

(A. SEIFERT OF DISTRICT 4)

12. - (A) PERCENTAGE OF FINE AGGREGATE:

$$\frac{8.0 - 6.5}{8.0 - 3.4} = \frac{1.5}{4.6} = 33 \text{ PER CENT OF FINE AGGREGATE}$$

67 DO DO DO COARSE DO

(B) PERCENTAGE OF FINE AGGREGATE:

$$\frac{6.5 - 5.8}{6.5 - 2.5} = \frac{0.7}{4.0} = 17 \text{ PER CENT OF FINE AGGREGATE}$$

83 DO DO DO COARSE DO

(9 CORRECT ANSWERS)

13. - FOR A PLASTIC MIXTURE, CONTAINING NO AIR VOIDS, THE VOLUME OF CONCRETE, PRODUCED FOR EACH BAG OF CEMENT, WILL BE EQUAL TO THE SUM OF THE ABSOLUTE VOLUMES OF THE CEMENT AND AGGREGATES, PLUS THE VOLUME OF WATER.

THEREFORE, FOR A 1:2:4 PROPORTION:

(A) - ABSOLUTE VOLUME OF CEMENT = $1 \times \frac{94}{3.10 \times 62.4} = 0.49$ CUBIC FOOT

DO DO DO SAND = $2 \times \frac{85}{2.65 \times 62.4} = 1.03$ DO FEET

DO DO DO COARSE AGGREGATE = $4 \times \frac{105}{2.70 \times 62.4} = 2.50$ DO DO

VOLUME OF WATER = $\frac{5.5 \text{ CUBIC FEET PER BAG OF CEMENT}}{7.5 \text{ GALLONS PER CUBIC FOOT}} = 0.73$ DO FOOT

VOLUME OF CONCRETE = 4.75 CUBIC FEET

THIS COMPUTATION GIVES THE VOLUME OF CONCRETE PRODUCED FOR EACH BAG OF CEMENT USED. THEREFORE, THE QUANTITY OF CEMENT REQUIRED FOR ONE CUBIC YARD OF CONCRETE WILL EQUAL

$$\frac{27}{4.75} = 5.7 \text{ BAGS, OR } 1.42 \text{ BARRELS.}$$

(B) - ABSOLUTE VOLUME OF CEMENT = $1 \times \frac{94}{3.10 \times 62.4} = 0.49$ CUBIC FOOT

DO DO DO SAND = $2 \times (1.00 \times 0.35) = 1.30$ DO FEET

DO DO DO COARSE AGGREGATE = $4 \times (1.00 - 0.45) = 2.20$ DO DO

VOLUME OF WATER = $\frac{6.0 \text{ CUBIC FEET PER BAG OF CEMENT}}{7.5 \text{ GALLONS PER CUBIC FOOT}} = 0.80$ DO FOOT

VOLUME OF CONCRETE = 4.79 CUBIC FEET

THEREFORE, THE QUANTITY OF CEMENT REQUIRED FOR ONE CUBIC YARD OF CONCRETE WILL EQUAL $\frac{27}{4.79} = 5.64$ BAGS, OR 1.41 BARRELS

(6 CORRECT ANSWERS)

14. - FINENESS MODULUS IS AN EXPRESSION USED TO INDICATE THE GRADING OF AN AGGREGATE. IT IS DETERMINED BY ADDING THE TOTAL PERCENTAGES OF THE MATERIAL RETAINED ON CERTAIN SIZE SIEVES, WITH SQUARE OPENINGS, AND DIVIDING THE RESULT BY 100. ABSOLUTE VOLUME AS APPLIED TO CONCRETE AGGREGATES IS THE ACTUAL VOLUME OF SOLID MATERIAL IN A GIVEN APPARENT VOLUME OF THE AGGREGATE. IN OTHER WORDS, IT IS THE DIFFERENCE BETWEEN THE APPARENT VOLUME AND THE VOLUME OF VOIDS. DENSITY AS APPLIED TO CONCRETE IS USUALLY TAKEN TO MEAN THE SUM OF THE ABSOLUTE VOLUMES OF THE CEMENT AND AGGREGATES (TOTAL SOLIDS) EXPRESSED AS A PERCENTAGE OF THE TOTAL VOLUME OF THE CONCRETE. WATER CEMENT RATIO IS THE VALUE OBTAINED BY DIVIDING THE VOLUME OF WATER BY THE VOLUME OF CEMENT USED IN A GIVEN BATCH OF CONCRETE. BULKING AS APPLIED TO CONCRETE SAND IS THE SWELLING OR INCREASE IN VOLUME WHICH TAKES PLACE WHEN A SMALL AMOUNT OF WATER IS ADDED TO DRY SAND. (W. D. ROSS OF DISTRICT 3)

15. - WATER MAY BE SAID TO EXIST IN BOTH THE COMBINED AND FREE FORM IN CONCRETE WHICH HAS HARDENED WITHOUT DRYING OUT. THE FINAL DENSITY OF THE CONCRETE IS ALMOST ENTIRELY CONTROLLED BY THE AMOUNT OF AIR VOIDS PRESENT, WHICH IN TURN IS A FUNCTION OF THE AMOUNT OF FREE WATER EXISTING IN THE CONCRETE WHEN IT STARTS TO DRY OUT. WHEN VIEWED FROM THIS STANDPOINT THE FUNCTION OF CURING IS TO DELAY THE FINAL DRYING OUT OF THE CONCRETE UNTIL THE GREATEST POSSIBLE PERCENTAGE OF THE TOTAL WATER HAS COMBINED WITH THE CEMENT THUS REDUCING THE PERCENTAGE OF FREE WATER AND CONSEQUENTLY THE FINAL VOIDS TO A MINIMUM. (A. F. HAELIG OF DISTRICT 7)

16. - The inundation method of measurement depends upon the principle that when a sand has become inundated or saturated with water so that all of the voids are filled, a given volume will contain approximately the same amount of sand as if the sand were dry. (A. Seifert of District 4)

17. - The principal advantages of specifying aggregates for concrete by weight are:

1. - It automatically corrects for the bulking action of moisture in sand.
2. - It makes possible an accurate preliminary estimate of the quantities of materials required for a given amount of concrete.
3. - It furnishes a record of the actual weights of materials used on a given job.

(K. S. Chamberlain of District 12)

18. - Because absolute volumes of aggregates will vary with their specific gravity and weights are only proportional to absolute volumes so long as the specific gravity is constant. For this reason variations in the specific gravity will produce variations in the absolute volume and consequently variations in the yield of the concrete produced. (K. S. Chamberlain of District 12)

19. - The determination of the weight per cubic foot of crushed blast-furnace slag. (8 correct answers)

20. - W = breaking load in pounds per lineal foot of pipe
1200 is the constant
D = internal diameter of the pipe in feet.
(7 correct answers)

21. - Galvanized metal culverts may well be used in locations where the soil waters are not unduly corrosive. Experience has shown that near the seacoast where tidal water affects the culvert or in the so-called alkali districts, such culverts corrode very rapidly. Before installing such culverts due consideration should be given to the life of galvanized culverts in that locality. (R. L. Devereaux of District 10)

22. - Exposure tests have shown that coppered steel, coppered iron, and pure iron, are the most lasting types of base metal. As yet we are not in a position to state that any one of the base metals specified under the so-called "5-way" specification is superior to any of the others. (K. S. Chamberlain of District 12)

23. - Red lead and the chromates of lead and zinc in contact with steel have proven to be the best inhibitors of corrosion. Since red lead is the only one of these that is generally available, and because it is nearly as good as the best, it is recommended as a shop coat and in general should be used also as a first field coat. It being assumed that the first two coats thoroughly cover the metal we may use for the second field coat a paint of more durable character when exposed to the weather even though it may not be as good an inhibitor of corrosion. For the second field coat a pigment consisting wholly or largely of basic lead sulphate or basic lead carbonate will prove satisfactory. (S. E. Sime of District 5)

24. - (a) Specific gravity, flash point, softening point, penetration, loss at 163°C. 5 hours, total bitumen soluble in carbon disulphide, ductility, proportion of total bitumen soluble in carbon tetra-chloride.

(b) Specific gravity, float test, distillation test, softening point of residue obtained in distillation test, total bitumen soluble in carbon disulphide.

(c) Specific gravity, flash point, specific viscosity, float test, loss at 163°C. 5 hours, total bitumen soluble in carbon disulphide, per cent of total bitumen insoluble in 86° Baumé naptha.

(d) Specific gravity, specific viscosity, float test, distillation test, softening point of residue obtained from distillation test, total bitumen soluble in carbon disulphide. (A. Seifert of District 4)

25. - (a) Penetration test; (b) float test; (c) specific viscosity and float test; (d) specific viscosity and float test, (A. F. Haelig of District 7)

26. - This test is made on asphalts for the purpose of ascertaining if the material will satisfactorily withstand the heating to which it is subjected at the asphalt paving plant. Results obtained in this determination are also taken as indicating whether or not the pavements constructed will age too rapidly, i.e., whether the pavements will crack excessively in a comparatively short time. (K. S. Chamberlain of District 12)

27. - Specification OC-2 is intended to provide for road oils which are to be applied cold, in the surface application treatment of roads. Since it is desired that these oils shall be capable of forming a mat or wearing surface on the road, it is advisable that they contain some comparatively volatile oils

WHICH, OF COURSE, WILL BE INDICATED WHEN THEY HAVE LOW FLASH POINTS. CONSEQUENTLY, A MAXIMUM PERMISSIBLE FLASH POINT IS SPECIFIED IN SPECIFICATION OC-2. (H. J. HEMSTREET OF DISTRICT 9)

28. - LET D = THEORETICAL SPECIFIC GRAVITY
W = WEIGHT PERCENTAGE OF MINERAL AGGREGATE
W_1 = WEIGHT PERCENTAGE OF ASPHALT CEMENT
S = SPECIFIC GRAVITY OF MINERAL AGGREGATE
S_1 = SPECIFIC GRAVITY OF ASPHALT CEMENT

THEN SUBSTITUTING IN THE FORMULA $D = \dfrac{100}{\frac{W}{S} + \frac{W_1}{S_1}}$

WE HAVE $D = \dfrac{100}{\frac{90}{2.65} + \frac{10}{1.03}}$

AND $D = 2.29$

THEN LET V = THE PERCENTAGE OF VOIDS AND D = THE SPECIFIC GRAVITY OF THE SAMPLE, THEN $V = \dfrac{100\,(D-d)}{D}$

SUBSTITUTING IN THIS FORMULA, THE PERCENTAGE OF VOIDS

$$V = \frac{100\,(2.29-2.20)}{2.29} = 3.93 \text{ PER CENT}$$

(4 CORRECT ANSWERS)

29. - (A) LET x = NUMBER OF POUNDS OF ASPHALT CEMENT

THEN $\dfrac{.998\ x}{900+x} = .10$

AND $.998\ x = 90+.1\ x$
AND $.898\ x = 90$
THEREFORE $x = 100.2$

(B) LET x = NUMBER OF POUNDS OF ASPHALT CEMENT
THEN $\dfrac{.80\ x}{900+x} = .10$

AND $.80\ x = 90+.1\ x$
AND $.7\ x = 90$
THEREFORE $x = 128.6$ (4 CORRECT ANSWERS)

30. - This test is ordinarily made at a temperature of 25°C. and as there is no standardized test for determining the adhesiveness of asphalts, it may be taken as indicating this property at normal temperatures. It also indicates in a measure the susceptibility of asphalts to temperature changes, since asphalts having extremely low ductilities at 25°C. such as the blown asphalts used as fillers, are only slightly susceptible to temperature changes. (H. S. Gillette of District 6)

31. - The test for total bitumen soluble in carbon disulphide is made for the purpose of determining the bitumen content, whereas the carbon tetra-chloride test is used for determining the carbenes in petroleum and asphalt products, the presence of which is considered to be indicative that the petroleum products have been subjected to some injurious manufacturing procedure, such as overheating. (A. Seifert of District 4)

32. - An ash correction should be made, and if this correction is not made the correct percentage of bitumen will not be determined by the analysis, since the bitumen reported will also include finely divided mineral matter which may have gone through the filter. The result for the material passing the 200-mesh sieve will also be affected since some of the material which should be reported as passing the 200-mesh sieve will be included with the bitumen. (H. C. Headley of District 8)

5-TON PYROTOL BLAST CAREFULLY EXECUTED ON COLORADO FOREST HIGHWAY PROJECT

COMPILED FROM REPORT SUBMITTED BY CLYDE E. LEARNED OF DISTRICT 3.

THE ADVANTAGES OF A CAREFULLY EXECUTED PLAN FOR OBTAINING SATISFACTORY RESULTS IN BLASTING OPERATIONS IS DEMONSTRATED BY THE SUCCESS OF THE 5-TON PYROTOL BLAST ON THE CHICAGO CREEK SECTION OF THE MOUNT EVANS FOREST HIGHWAY IN COLORADO. THE BLAST WHICH WAS FIRED ON THE AFTERNOON OF NOVEMBER 26, 1927, WAS SPECTACULAR AS WELL AS SUCCESSFUL - AT LEAST THREE-QUARTERS OF THE TOTAL YARDAGE MOVED BEING THROWN CLEAR OF THE ROADWAY AND PILED UP ON THE MOUNTAIN SIDE AND CANYON BELOW TO A DEPTH OF 15 TO 30 FEET. THE PRISM OF THE ROAD AS COMPUTED TOTALLED 9,100 CUBIC YARDS WHICH, IN ADDITION TO AN ALLOWANCE OF 10 PER CENT OF THE PRISM YARDAGE, CAUSED BY AN OVERBREAK OF 3,500 CUBIC YARDS, MADE A GRAND TOTAL OF 10,000 CUBIC YARDS ALLOWED TO THE CONTRACTOR. THE TOTAL AMOUNT OF PYROTOL USED WAS 10,200 POUNDS. THIS AVERAGED PRACTICALLY A POUND OF EXPLOSIVE PER CUBIC YARD OF PAY YARDAGE OR EIGHT-TENTHS OF A POUND OF PYROTOL FOR EACH YARD OF THE TOTAL BURDEN MOVED.

THE FRAGMENTATION OF THE MATERIAL IN FRONT OF AND OVER THE CHARGE WAS EXCELLENT. THE ONLY LARGE PIECES OF ROCK REMAINING AFTER THE "SHOT" WERE IN THE OVERBREAK MATERIAL ALONG THE BACK SLOPE (FIG. 2-B). THESE LARGE FRAGMENTS, UNFORTUNATELY FOR THE CONTRACTOR, SLID DOWN THE SLOPE AND PILED UP IN THE ROADWAY, THUS NECESSITATING CONSIDERABLE DRILLING AND BREAKING BEFORE THEY COULD BE MOVED WITH THE STEAM SHOVEL. ABOUT 1,000 CUBIC YARDS OF THE BLASTED ROCK WAS USED IN THE CONSTRUCTION OF A 40-FOOT HAND-PLACED EMBANKMENT BELOW AND CONTIGUOUS TO THE CUT. THE GREATER PORTION OF THE BLASTED MATERIAL, HOWEVER, WAS WASTED.

THE BLAST MADE VERY LITTLE NOISE, EACH INDIVIDUAL SEAM IN THE CLIFF OPENING UP AS THOUGH A HERCULEAN GIANT WERE SLOWLY FORCING HIS WAY UPWARD FROM BELOW (FIG. 1-B). AS THE SEAMS WIDENED, JETS OF SMOKE SHOT OUT INTO THE AIR, FORMING A MANTLE OVER THE ENTIRE MASS OF MOVING ROCK, WHICH SOON BECAME ENVELOPED BY THE SMOKE. THEN AS THE MASS BEGAN TO FALL, THE ROCKS PILED UP IN THE CANYON BELOW, WHILE THE CLOUD OF SMOKE CONTINUED TO ROLL FIRST ACROSS THE CANYON AND THEN UP THE OPPOSITE SLOPE OF THE MOUNTAIN (FIG. 2-A). THE ENTIRE PROCEEDING WAS A MOST EXCITING, BEAUTIFUL, AND AWE-INSPIRING SIGHT.

Figure 1-A. - The portal of the upper tunnel. The rope in the upper left corner of the picture was used by the workmen in going to and from the work.

Figure 1-B. - The blast, of 35,000 tons of rock, getting away to a nice start.

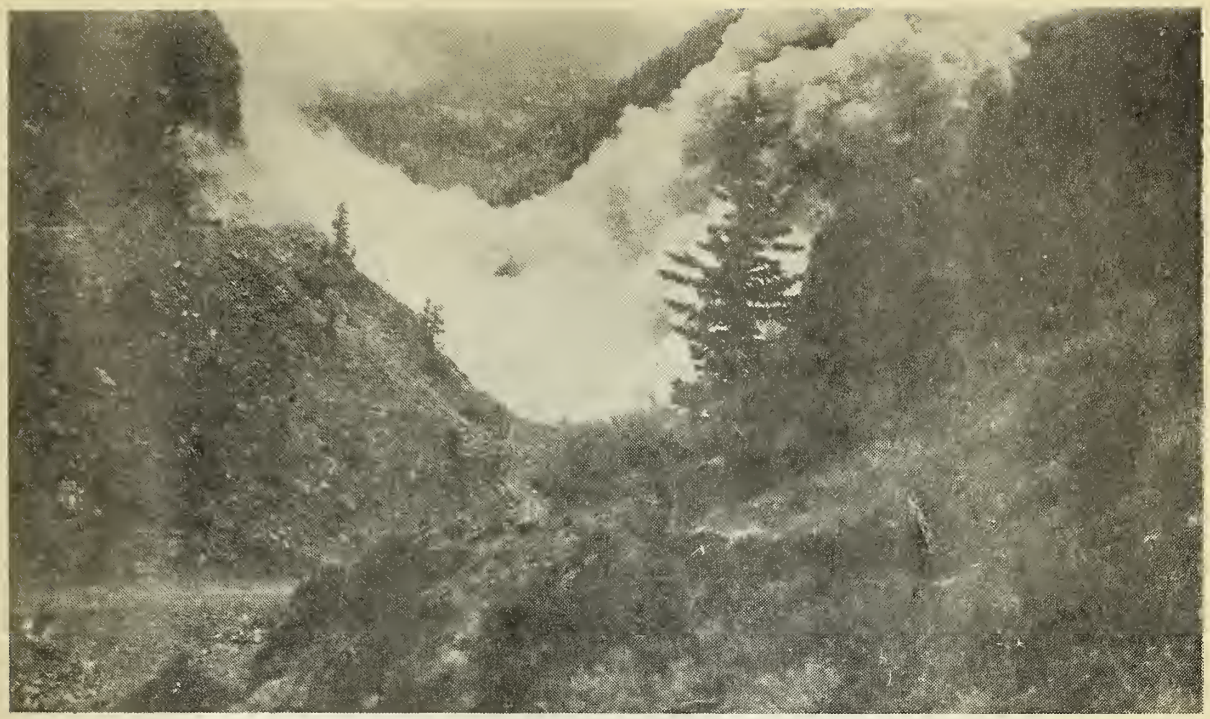


Figure 2-A. - Immediately after the blast - the rock settling into the canyon below and the dense smoke cloud rolling up the opposite side of the mountain.

Figure 2-B. - After the smoke cleared away - cliff removed to a height of 135 feet and the old road blocked with rock fragments.

Directly over the blast the escaping pyrotol gases re-ignited spontaneously as they came in contact with the air - the sheet of flame setting fire to the brush and trees on the cliff above. This phenomenon was attributed to the lack of oxygen in the explosive to provide for complete combustion of the pyrotol mixture.

Location of Blast

The blast was the result of a choice between driving a tunnel through a rocky promontory which jutted out into the canyon of the Chicago Creeks, or of notching out a 40 to 50-foot shelf in the face of the cliff. The latter course was adopted. The blast was located between Stations 325+15 and 326+40 of Chicago Creek section No. 2 of the forest highway between Echo Lake and Idaho Springs - 40 miles west of Denver, Colorado. (See attached sketch). The construction of this road has been carried on by the Bureau during the past three seasons. Three sections, totalling seven miles, have been put under contract. On all of this mileage, located through a very mountainous region, a total of 160,000 cubic yards of material has been moved - approximately 40 per cent of this being classed as solid rock. The third section, on which the 5-ton pyrotol blast is located, is known as Chicago Creek section No. 2. It is $1\frac{1}{4}$ miles long and contains over 45,000 cubic yards of excavation, of which approximately 70 per cent is rock. A considerable length of this section is located through granite formations, high up on the mountain slopes.

Method of Preparing Blast

The method followed by the contractor in removing the cliff - a close-grained, gray-granite formation, was to drive a small tunnel or coyote hole in from each end of the cut (fig. 1-A), excavate pockets at a number of strategic points and load them with pyrotol, and finally to shoot the entire charge in one blast.

On the lower or northern end, the face was fairly accessible (see sketch map and fig. 1), as the steam shovel had just completed a pilot cut to within a hundred feet of the proposed portal, and it was not very difficult to blast out a narrow path for the remainder of the distance. This tunnel, designated as No. 1 on the sketch map, was started on about the center line of the road, and was driven at an angle of about 30 degrees to the

ditch - a distance of 35 feet. From this point, two headings were bored in opposite directions along the ditch line, each being 15 feet in length, and the layout of the two completing the shape of a bent Tee.

On the up-grade side of the cliff, the operations were rather difficult and of a more hazardous nature. It was necessary to lower the men, equipment, and explosives from the cliffs above. The drilling crews were held with ropes or slings while they cut out a bench from which they were able to begin driving the tunnel. This No. 2 tunnel was driven at grade for 60 feet along the ditch line to within 15 feet of the end of tunnel No. 1.

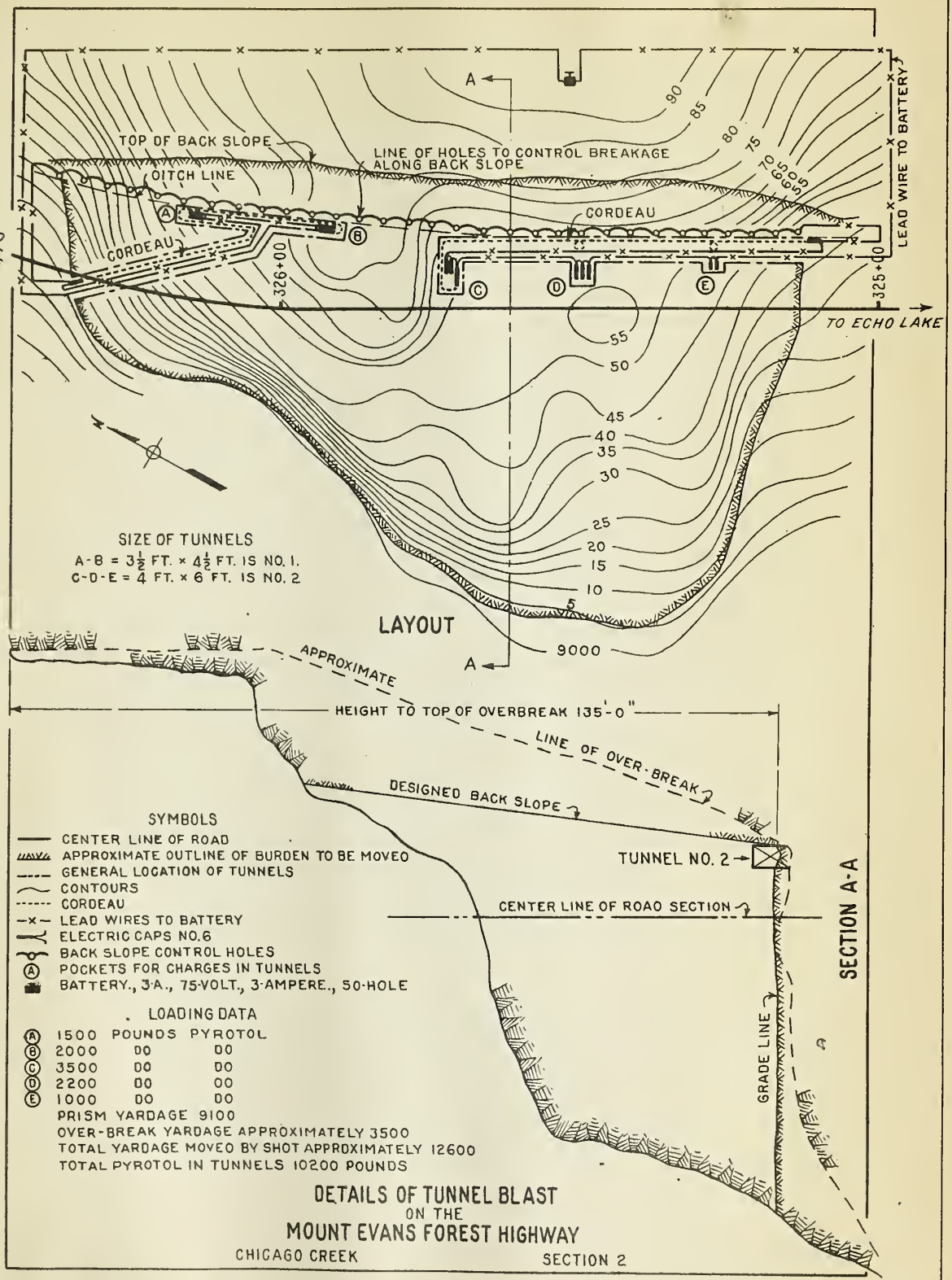
At 20-foot intervals, right-angle offset chambers were sunk so as to obtain more complete confinement of the charges for the blast. These offset chambers were from 6 to 15 feet in length and from 2 to 4 feet below the tunnel floor.

Jack hammer drills, mounted on columns, with water-feed connections, were used in driving the tunnels, the average daily progress in each being three feet. The drilling and mucking operations were handicapped considerably by the confined space in which the crew were forced to work.

Explosives Carefully Proportioned

The amount of explosive in each pocket was proportioned in accordance with its position and the amount of burden to be moved. The tunnels were loaded as follows:

	Pounds of pyrotol
Tunnel No. 1 - Pocket A - - - - - - - -	1,500
do do - do B - - - - - - - -	2,000
do No. 2 - do C - - - - - - - -	3,500
do do - do D - - - - - - - -	2,200
do do - do E - - - - - - - -	1,000
Total	10,200



DETAILS OF TUNNEL BLAST
ON THE
MOUNT EVANS FOREST HIGHWAY
CHICAGO CREEK SECTION 2

The explosive used was the pyrotol furnished by the Government and manufactured by the du Pont Company from surplus War Department supplies. The contractor had used pyrotol previously in carrying on regular blasting operations in this section, but since there was no record of its use on large blasts, the local du Pont representatives obtained for the contractor, by wire from their main office, information concerning its use. The pyrotol was the customary mixture of ground smokeless and hand grenade powder. To this had been added about 10 per cent of nitroglycerin dynamite to act as a sensitizer. The product obtained by this mixture was a low-freezing compound equivalent to about 40-per-cent dynamite. In loading the pockets, the precaution was taken of adding 100 pounds of ammonia dynamite to insure complete detonation of each charge of pyrotol.

Dual Detonating System Used as a Precaution

A dual detonating system, consisting of both electric blasting caps and Cordeau fuse, was used to insure the complete explosion of the charges. An electric cap and a primer of dynamite were connected with the Cordeau fuse, at the inner ends of the tunnels, as an extra precaution. In each of the pocket charges, 2 or 3 electric blasting caps to act as primers, were inserted in sticks of 40-per-cent dynamite, and the Cordeau fuse was coiled through the charge of pyrotol.

All electric blasting caps were connected in a single series with double No. 20 wires which led to the tunnel entrances. The wires, after being first wrapped, were laid along one of the lower corners of the tunnel, and then covered with heavy paraffined box paper over which was spread a layer of loose soil. Each electric cap was tested before being placed in position and frequent galvanometer tests were made on the wiring as the tunnels were backfilled.

With the purpose of obtaining a clean-cut and uniform back slope to the cut, a series of holes were drilled along the line of the top of the proposed back slope, and these holes were loaded with gelatine dynamite. The result of this blast was unsatisfactory, in this respect, because of a number of inclined cleavage planes which caused the cliff to overbreak at the top for a distance of 10 to 25 feet.

Details of the Electrical Connections

A detailed description of the electrical connections follows: A single electrical circuit was first passed through the electric blasting caps in the pockets; the innermost of the caps had a Cordeau fuse connected to it. The electrical circuit was then continued back to the entrance of the tunnel where the outside Cordeau connection was made. The Cordeau fuse ran the entire length of the tunnels with loops in each of the pyrotol charges.

From the tunnel entrance the circuit passed over the cliff through the back-slope line of drill holes, thence down the other side of the cliff to the second tunnel, through the pockets to the inside end of the Cordeau and back to the entrance, where the outside electrical connection was made. Double lines of No. 14 leading wires were run from the two tunnel entrances to the top of the mountain where a 50-hole blasting machine was used to fire the blast.

The circuit was carefully tested with a galvanometer. The results of the tests, on the du Pont Type 3-A blasting machines, made with a rheostat, showed that sufficient current was generated to fire 100 holes. This indicated an ample factor of safety since there were only 40 electric blasting caps in the entire series.

For the benefit of those not familiar with Cordeau, it may be stated that this is the trade name for a powerful detonating fuse. It consists of a small lead tube - approximately 3/16 of an inch in diameter - compactly filled with the highly explosive T.N.T.. This fuse has a velocity of detonation of about 3 miles per second. It is exploded by regular blasting of electric caps which must be placed in actual contact with the T.N.T. in the tube. Special caps and connections are manufactured for this purpose.

The use of Cordeau is usually recommended for blasts similar to the one herein described. In this particular case it was used as an additional precaution against failure, for had the electric wiring within the tunnel become broken, or had the electric caps failed to explode, the extreme violence of the Cordeau explosion would have been sufficient to detonate all of the pyrotol. Cordeau is a regular commercial product, sold in 500-foot spools, the cost being about 6 cents per lineal foot.

Tunnels Backfilled Carefully

Following the placing of the charges in the sink holes or offset chambers, the tunnels were carefully backfilled to within 5 or 10 feet of the entrances with muck obtained from the tunnel excavation. When the blast was fired, no projectile or blowout effect was observed at either entrance; all the generated energy was utilized apparently in doing effective work. The rock, within the prism section of the road, broke from 2 to 6 feet below grade, except along the ditch line where it broke to the elevation of the tunnel floor.

Cost of the Blast

The tunnels were driven by the contractor, first on a day-labor basis. Then, in order to speed up the work, he let them out by station contract, furnishing all the necessary materials and equipment as well as the air. A total of 155 lineal feet of tunnel and offset chambers were driven.

The cost of drilling, shooting, and mucking out the tunnels and offset chambers was approximately $11.00 per lineal foot. This cost in terms of the pay yardage moved by the blast is equivalent to a unit price of 17 cents per cubic yard. The cost of loading, backfilling, and firing the blast totalled 16 cents per cubic yard. The preceding figures include all labor, material, explosives, rental charges, and a liberal allowance for overhead expense and supervision. The pyrotol was furnished to the contractor by the Government at a cost of 12 cents a pound.

As the work was closed down for the winter before the completion of the excavation, no exact final cost figures can be given, but from the data on hand it seems reasonable to estimate that the final cost will be about 50 cents per cubic yard of pay yardage.

The contractor on the work was E. Honnen of Colorado Springs. He was assisted by A. E. Anderson, technical representative of the du Pont Company, in the loading, testing, and firing of the blast. The Bureau resident engineer on the project was C. R. Lugton.

PROGRESS OF FEDERAL HIGHWAY LEGISLATION

(NOT FOR RELEASE)

NEW BILLS INTRODUCED IN CONGRESS SINCE THE LAST ISSUE OF THE NEWS LETTER AND FURTHER ACTION ON BILLS PREVIOUSLY INTRODUCED ARE SUMMARIZED BELOW. IN ADDITION TO THIS ACTION, HEARINGS ARE IN PROGRESS ON THE FOLLOWING BILLS: H.R. 358, H.R. 383, H.R. 5518, H.R. 7019, H.R. 7343, AND H.R. 8832.

H.R. 8269. - SIGNED BY THE PRESIDENT ON FEBRUARY 15, AFTER HAVING BEEN PASSED BY BOTH HOUSES OF CONGRESS. MAKES APPROPRIATIONS FOR THE DEPARTMENTS OF STATE AND JUSTICE AND FOR THE JUDICIARY, AND FOR THE DEPARTMENTS OF COMMERCE, AND LABOR, FOR THE FISCAL YEAR ENDING JUNE 30, 1929, AND FOR OTHER PURPOSES. MAKES AN APPROPRIATION OF $3,000 TO PAY THE QUOTA OF THE UNITED STATES IN THE PERMANENT ASSOCIATION OF INTERNATIONAL ROAD CONGRESSES, AS AUTHORIZED BY THE PUBLIC RESOLUTION APPROVED JUNE 18, 1926.

H.R. 9136. - INTRODUCED IN THE HOUSE ON FEBRUARY 6. THIS IS THE APPROPRIATION BILL FOR THE DEPARTMENT OF INTERIOR FOR THE FISCAL YEAR ENDING JUNE 30, 1929. FOR THE CONSTRUCTION OF ROADS AND TRAILS IN THE NATIONAL PARKS, AS AUTHORIZED BY THE ACT APPROVED JUNE 5, 1924, THERE IS APPROPRIATED $2,500,000, WHICH INCLUDES $1,500,000, THE REMAINDER OF THE CONTRACTUAL AUTHORIZATION FOR THE FISCAL YEAR 1928. IN ADDITION TO THE AMOUNT APPROPRIATED AS ABOVE, THE SECRETARY OF INTERIOR MAY APPROVE PROJECTS, INCUR OBLIGATIONS, AND ENTER INTO CONTRACTS FOR ADDITIONAL WORK NOT EXCEEDING A TOTAL OF $4,000,000.

H.R. 11209. - INTRODUCED IN THE HOUSE ON FEBRUARY 20, BY O. B. BURTNESS OF NORTH DAKOTA, AND REFERRED TO THE COMMITTEE ON ROADS: PROVIDES FOR THE AMENDMENT OF SECTION 2 OF THE FEDERAL HIGHWAY ACT, SO THAT THE TERM "HIGHWAY", AS THEREIN CONTAINED, SHALL HEREAFTER READ AS FOLLOWS: "THE TERM 'HIGHWAY' INCLUDES RIGHTS OF WAY, BRIDGES, DRAINAGE STRUCTURES, SIGNS, GUARD RAILS, AND PROTECTIVE STRUCTURES IN CONNECTION WITH HIGHWAYS, BUT SHALL NOT INCLUDE ANY HIGHWAY OR STREET IN A MUNICIPALITY HAVING A POPULATION OF TWO THOUSAND FIVE HUNDRED OR MORE AS SHOWN BY THE LAST AVAILABLE CENSUS, EXCEPT THAT PORTION OF ANY SUCH HIGHWAY OR STREET ALONG WHICH THE HOUSES AVERAGE MORE THAN TWO HUNDRED FEET APART."

H.R. 11210. - Introduced in the House on February 20, by C. B. Burtness of North Dakota, and referred to the Committee on Roads: Provides that existing Federal-aid legislation be amended so that "the Secretary of Agriculture may extend Federal aid under such acts, in the construction of any free highway bridge and approaches thereto, by a State, States, county or counties, or any other political subdivision of any such State or States, where any part or all of such bridge is located within a municipality having a population of two thousand five hundred or more, as shown by the last available census, providing such bridge is an interstate bridge crossing a stream separating two States (Regardless of whether or not within a distance of one mile from such bridge the houses average more than two hundred feet apart)."

H.R. 11280. - Introduced in the House on February 21, by L. C. Warren of North Carolina, and referred to the Committee on Roads: Authorizes an appropriation of $10,000,000 as an emergency relief fund to be expended by the Secretary of Agriculture in the repair of highways or bridges damaged or destroyed by floods. Provides that the money shall be expended in accordance with the provisions of the Federal Highway Act, except that the $15,000-per-mile limitation shall not prevail, and that the restriction upon the expenditure of Federal funds in towns with a population of 2,500 or more shall not apply.

H.R. 11464. - Introduced in the House on February 27, by Tom Connally of Texas, and referred to the Committee on Roads. This bill is identical with S. 3081 described in the last issue of the News Letter.

H.R. 11485. - Introduced in the House on February 27, by E. E. Denison of Illinois, and referred to the Committee on Interstate and Foreign Commerce: Provides for the amendment of the act regulating the construction of bridges over navigable waters as approved March 23, 1906, to provide among other things as follows: That hereafter it shall not be lawful to construct a bridge over <u>any</u> of the navigable waters of the United States without the authority or consent of Congress; nor until the plans and specifications have been approved by the Chief of Engineers of the Army and the Secretary of War. That any bridge built under the provisions of the Act shall be recognized as a post route upon which certain provisions with respect to charges for use by the United States, and telegraph, telephone, electric light, gas, and water companies, shall apply. That all railroad companies shall be entitled to equal privileges

IN THE USE OF SUCH BRIDGES AND THAT DISPUTES SHALL BE SETTLED BY THE INTERSTATE COMMERCE COMMISSION. THAT FAILURE TO COMPLY WITH A LAWFUL ORDER OF THE SECRETARY OF WAR OR THE INTERSTATE COMMERCE COMMISSION RELATIVE TO SUCH A BRIDGE SHALL BE A MISDEMEANOR PUNISHABLE BY A FINE OF NOT TO EXCEED $5,000. THAT, IF TOLLS ARE CHARGED FOR TRANSIT OVER ANY BRIDGE HERETOFORE OR HEREAFTER CONSTRUCTED OVER ANY NAVIGABLE WATER OF THE UNITED STATES AND FORMING A PART OF OR A CONNECTING LINK WITH A FEDERAL-AID HIGHWAY OR A HIGHWAY UPON WHICH INTERSTATE COMMERCE OR THE U.S. MAILS IS OR MAY BE CONVEYED, SUCH TOLLS SHALL BE UNIFORM, JUST, AND REASONABLE, AND SUBJECT TO REGULATION BY THE INTERSTATE COMMERCE COMMISSION. THAT THE INTERSTATE COMMERCE COMMISSION IS AUTHORIZED TO INVESTIGATE AND DETERMINE THE FAIR REASONABLE VALUE, ACTUAL COST, AND REASONABLE COST OF BRIDGES OVER ANY NAVIGABLE WATERS WHENEVER IT SHALL BE NECESSARY OR DESIRABLE TO DO SO, UNDER THE FOLLOWING CONDITIONS: (1) IF THE BRIDGE IS A PRIVATELY-OWNED TOLL BRIDGE AND IS PART OF OR A CONNECTING LINK OF THE FEDERAL-AID HIGHWAY SYSTEM, OR OF HIGHWAYS ON WHICH INTERSTATE COMMERCE IS CONVEYED, THE COMMISSION MAY DETERMINE THE FAIR REASONABLE VALUE. (2) IF THE BRIDGE IS A PRIVATELY-OWNED TOLL BRIDGE CONSTRUCTED WITHIN THREE YEARS BEFORE THE APPROVAL OF THE ACT OR AFTER ITS APPROVAL THE COMMISSION MAY, WITHIN THREE YEARS OF THE APPROVAL OF THE ACT OR OF THE COMPLETION OF THE BRIDGE, DETERMINE THE ACTUAL COST AND WHAT WOULD BE A REASONABLE COST OF CONSTRUCTION. THAT THE COMMISSION IS AUTHORIZED TO DETERMINE THE VALUE OR ACTUAL AND REASONABLE COSTS UPON ITS OWN MOTION, OR UPON COMPLAINT OF INTERESTED PERSONS, OR UPON REQUEST OF THE HIGHWAY DEPARTMENT OF THE STATE IN WHICH THE BRIDGE IS WHOLLY OR PARTLY LOCATED. THAT PREVIOUS LEGISLATION GRANTING THE SECRETARY OF WAR OR CHIEF OF ENGINEERS AUTHORITY TO PRESCRIBE RATES OF TOLL IS REPEALED AND SUCH AUTHORITY IS TRANSFERRED TO THE INTERSTATE COMMERCE COMMISSION. THAT WHEN AUTHORITY HAS BEEN GRANTED TO CONSTRUCT A HIGHWAY BRIDGE OVER A NAVIGABLE WATERWAY WHERE IT FORMS A BOUNDARY BETWEEN STATES, THE OWNERS OR OPERATORS ARE AUTHORIZED TO FIX AND CHARGE TOLLS WHICH SHALL BE LEGAL UNTIL CHANGED BY THE INTERSTATE COMMERCE COMMISSION; AND UPON SUCH OWNERS THE ACT CONFERS THE SAME POWERS OF CONDEMNATION AND EXPROPRIATION AS ARE POSSESSED BY RAILROAD CORPORATIONS OR BRIDGE CORPORATIONS IN THE STATE IN WHICH THE AFFECTED PROPERTY IS LOCATED. THAT WITHIN 90 DAYS AFTER THE COMPLETION OF A TOLL BRIDGE AN ITEMIZED STATEMENT OF COST SHALL BE FILED WITH THE INTERSTATE COMMERCE COMMISSION AND THE STATE HIGHWAY DEPARTMENT. THAT TOLLS ON PRIVATE BRIDGES SHALL BE SUFFICIENT TO COVER MAINTENANCE, OPERATING, AND AMORTIZATION CHARGES, AND THAT THE BRIDGES MAY BE

taken over by the State or any political subdivision by purchase or condemnation in accordance with State laws, and if taken over after the tolls collected have been sufficient to amortize the reasonable cost of the bridge, the compensation to be allowed shall not include good will, going values, or prospective revenues or profits. That tolls on public bridges shall be sufficient to cover maintenance, operating, and amortization charges, and that the structures shall become free after the cost has been amortized. That authority granted by Congress to construct bridges over navigable waters may be sold, assigned or transferred.

H.R. 11577. - Introduced in the Senate on March 5, and referred to the Committee on Appropriations. This is the agricultural appropriation bill for the fiscal year ending June 30, 1929. Appropriates for forest roads and trails, under Section 23 of the Federal Highway Act, $6,500,000 which is composed of $3,945,000, part of the sum of $7,500,000 authorized to be appropriated for the fiscal year 1928 by the Act approved June 22, 1926, and $2,555,000 part of the amount authorized to be appropriated for the fiscal year 1929 by the Act approved June 22, 1926. Also provides that upon the approval of this Act the $7,500,000 available for forest roads for the fiscal year 1929 shall be apportioned and prorated. For building Federal-aid roads there is appropriated $71,000,000. This sum is composed of $27,800,000, the remainder of the $75,000,000 authorized for the fiscal year ending June 30, 1927; and $43,200,000, part of the $75,000,000 authorized for the fiscal year ending June 30, 1928.

H.R. 12040. - Introduced in the House on March 13, by C. G. Edwards of Georgia, and referred to the Committee on Roads: Provides that the Federal-aid highways shall be named as well as numbered on maps and directional signs in order to perpetuate the purposes of such memorials.

H.Res. 117. - Introduced in the House on February 20, by W. J. Sears of Florida, and referred to the Committee on Roads: Authorizes the Bureau to make a survey to determine the cost of certain bridges on United States route 1 and its extension from the Florida mainland to Key West.

H. Res. 119. - Introduced in the House on February 21, by E. Celler of New York, and referred to the Committee on Labor: Provides that the President shall authorize the heads of all departments and bureaus to speed up all Government building and construction, in order to reduce the amount of unemployment,

S. 1341. - Introduced in the Senate on December 6, by T. L. Oddie of Nevada: Passed the Senate on March 2, and referred to the Committee on Roads of the House on March 6.

S. 1369. - Introduced in the Senate on December 6, by C. A. Swanson of Virginia. Passed the Senate on March 6, and referred to the Committee on Roads of the House on March 8.

S. 3184. - Introduced in the Senate on February 13, by B. Cutting of New Mexico, and referred to the Committee on Post Offices and Post Roads: Provides for the amendment of existing Federal-aid road legislation, by authorizing an appropriation of $3,500,000 for each of the fiscal years 1929, 1930, and 1931, for the construction and maintenance by the Bureau, of the main roads in the public-land States, through unappropriated or unreserved public lands, non-taxable Indian lands, or other Federal reservations. A similar bill (H.R. 7343) was reported in the December 1927 News Letter.

S.3559. - Introduced in the Senate on March 8, by J. E. Watson of Indiana, and referred to the Committee on Post Offices and Post Roads: Provides that the proceeds from the sale of surplus war material and supplies to the Government of France, amounting to $407,341,145 be used for the construction of Federal-aid and forest roads, and park roads in the District of Columbia. A similar bill (H.R. 10142) was described in the last News Letter.

S.J. Res. 30. - Introduced in the Senate on December 12, by L. C. Phipps of Colorado: Passed by the Senate and referred to the House and reported out without amendment by the House Committee on Foreign Affairs on March 2, 1928.

S.J. Res. 31. - Introduced in the Senate on December 12, by L. C. Phipps of Colorado: Passed by the Senate and referred to the House and reported out without amendment by the House Committee on Foreign Affairs on March 2, 1928.

AUSTIN BRADSTREET FLETCHER

(NOT FOR RELEASE)

AUSTIN BRADSTREET FLETCHER, CONSULTING ENGINEER FOR THE BUREAU, DIED OF PNEUMONIA AT 3 P.M., MARCH 8, AT HIS HOME, 24 HESKETH STREET, CHEVY CHASE, MARYLAND. HE HAD BEEN ILL ONLY A WEEK. WHILE MAKING A HIGHWAY ACCIDENT STUDY FOR THE BUREAU, HE CONTRACTED A COLD AT CLEVELAND, OHIO, WHICH UPON HIS RETURN TO WASHINGTON GREW STEADILY WORSE AND FINALLY DEVELOPED INTO ACUTE PNEUMONIA.

MR. FLETCHER WAS WIDELY KNOWN AND RESPECTED AS A LEADER IN THE FIELD OF HIGHWAY ENGINEERING. AS STATE HIGHWAY ENGINEER OF CALIFORNIA, FROM 1909 TO 1919, HE RENDERED CONSPICUOUS SERVICE IN THE FORMULATION AND DIRECTION OF THE PROGRAM OF MODERN ROAD IMPROVEMENT IN THAT STATE.

WITH THE CREATION OF THE CALIFORNIA DEPARTMENT OF PUBLIC WORKS IN 1919, MR. FLETCHER BECAME THE DIRECTOR OF PUBLIC WORKS, A POSITION WHICH HE HELD UNTIL 1923 AND IN WHICH HE WAS IN CHARGE OF ALL ENGINEERING WORKS OF THE STATE.

IN THE SUMMER OF 1923 HE SERVED AS CONSULTING ENGINEER FOR THE NEW ENGLAND RAIL COMMITTEE, A BODY MADE UP OF REPRESENTATIVES OF THE SIX NEW ENGLAND STATES, AND CHARGED WITH THE DUTY OF STUDYING THE ENTIRE TRANSPORTATION SITUATION IN NEW ENGLAND. MR. FLETCHER WAS CALLED UPON TO MAKE A SPECIAL STUDY AND REPORT OF HIGHWAY TRANSPORTATION CONDITIONS.

SINCE JULY, 1924, HE HAS SERVED AS CONSULTING HIGHWAY ENGINEER FOR THE BUREAU, CONTINUING IN THIS CONNECTION HIS VALUABLE SERVICES TO THE CAUSE OF ROAD IMPROVEMENT IN THE UNITED STATES.

MR. FLETCHER WAS BORN AT CAMBRIDGE, MASS., JANUARY 19, 1872. HE WAS A GRADUATE OF THE LAWRENCE SCIENTIFIC SCHOOL OF HARVARD UNIVERSITY, FROM WHICH HE RECEIVED AN S. B. DEGREE IN 1893. FOR SEVERAL YEARS AFTER HIS GRADUATION HE WAS THE SECRETARY AND EXECUTIVE OFFICER OF THE MASSACHUSETTS HIGHWAY COMMISSION, ONE OF THE EARLIEST OF THE STATE HIGHWAY DEPARTMENTS. IN THE SUMMER OF 1916 HE WAS SELECTED BY THE SECRETARY OF AGRICULTURE TO ASSIST IN DRAFTING RULES AND REGULATIONS FOR CARRYING INTO EFFECT THE FEDERAL-AID ROAD ACT, PASSED BY CONGRESS IN THAT YEAR. HE WAS A MEMBER OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, THE AMERICAN SOCIETY FOR TESTING MATERIALS, THE

Boston Society of Civil Engineers, the American Association of State Highway Officials, the Association Internationale Permanente des Congres de la Route, and various other engineering societies, a fellow of the American Geographical Society, a member of the Massachusetts Society of Sons of the American Revolution and of the Society of Colonial Wars of California. He was also a member of the Cosmos Club, Washington, D. C., the Harvard Club of San Francisco, and the Harvard Engineers Club of New York City.

He is survived by his wife Ethel and one daughter, Mrs. Laurence H. Chapman of Sacramento, California.